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Monsanto Research Corp, Dayton, OH

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Status Assessment of Toxic Chemicals

Lead

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16. ABSTRACT

The uses of lead and the sources of lead pollution (both natural and man-made) are identified. Long-range projections concerning the lead usage are made and proposed new emissions standards are examined. The current control technology is explained and areas for future study are delineated in the report.

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Please change the following:

page iii, paragraph 2, line 3, from "polybrominated biphenyls" to "lead".

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STATUS ASSESSMENT OF TOXIC CHEMICALS: LEAD

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FOREWORD

When energy and material resources are extracted, processed, converted, and used, the related pollutional impacts on our environment and even on our health often require that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory - Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

This report contains a status assessment of the air emissions, water pollution, health effects, and environmental significance of polybrominated biphenyls. This study was conducted to provide a better understanding of the distribution and characteristics of this pollutant. Further information on this subject may be obtained from the Organic Chemicals and Products Branch, Industrial Pollution Control Division.

Status assessment reports are used by IERL-Ci to communicate the readily available information on selected substances to government, industry, and persons having specific needs and interests. These reports are based primarily on data from open literature sources, including government reports. They are indicative rather than exhaustive.

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ABSTRACT

Lead has been recognized as a health hazard because it is widely used and a toxic substance. In 1974, a total of 1.2×10^6 metric tons of lead were produced from primary and secondary operations. The air emissions from production and use are 16,414 metric tons/yr, while water effluents are estimated at 4,726 metric tons/yr. Little data are available on water effluents of lead other than from lead-acid battery manufacture where the chemical is as lead sulfate, lead hydroxide and a small amount of suspended solids. Air emissions from waste incineration and automobiles are a major source of lead.

Lead occurs naturally in water at levels usually below 50 mg/m^3. Even rainwater has been shown to contain an average of 34 mg/m^3 although some of this may be due to automotive exhaust. Rainwater in heavy traffic may exceed 100 mg of lead per cubic meter. Lead in soil varies from 2 mg/kg to 200 mg/kg with a mean of 16 mg/kg, but levels of lead in street dust, residential and commercial areas of the U.S., has been observed to average 1,600 mg/kg and 2,400 mg/kg, respectively. Urban areas have shown ambient lead levels (1 $\mu g/m^3$ to 3 $\mu g/m^3$) over an order of magnitude higher than suburban areas and two orders of magnitude over rural areas. Gasoline additives and waste incineration have been the major sources in all urban areas and are, most likely, the present cause of high urban lead levels. Lead levels in air may decline due to the reduction of lead in gasoline; however, soil and water levels will not change rapidly due to the low reactivity of lead.

Control of lead from smelting operations is accomplished by baghouses, electrostatic precipitators and wet scrubbers. Lead is removed from wastewaters by the addition of lime or caustic soda as exemplified by the lead-acid battery industry.

EPA has proposed setting a new ambient air quality standard for lead of 1.5 $\mu g/m^3$ air. This standard is expected to affect lead and copper smelters who will be forced to invest capital into additional pollution control equipment. Lead has been designated as a priority pollutant under the Federal Water Pollution Control Act. Water criteria for lead will be reviewed by the end of 1979.

Additional information will be needed on lead to initiate further regulatory actions. The biological and chemical pathways of lead from its sources to the environment need to be studied further for effective control of lead pollution. The number of persons exposed to lead contamination from specific sources is not known, making it difficult to assess the potential health hazards. Also the hazards to the consumer caused by lead migration from various products is still under investigation.

This report was submitted in partial fulfillment of Contract 68-03-2550 by Monsanto Research Corporation under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period November 1, 1977 to December 31, 1977. The work was completed as of January 20, 1978.

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CONVERSION FACTORS AND METRIC PREFIXES[a]

CONVERSION FACTORS

To convert from	to	Multiply by
Degree Celsius (°C)	Degree Fahrenheit	$t_F^\circ = 1.8\ t_C^\circ + 32$
Joule (J)	Foot-pounds	0.7376
Kilogram (kg)	Pound-mass (pound-mass avoirdupois)	2.204
Meter (m)	Foot	3.281
Meter^3 (m^3)	Foot^3	3.531×10^1
Metric ton	Pound-mass	2.205×10^3
Metric ton	Kilogram	1.000×10^3
Metric ton	Ton (short, 2,000 pound-mass)	1.585×10^{-4}
Pascal (Pa)	Pound-force/inch^2 (psi)	1.450×10^{-4}
Watt (W)	British thermal units/hr (Btu/hr)	3.413

METRIC PREFIXES

Prefix	Symbol	Multiplication factor	Example
Centi	c	10^{-2}	$1\ cm = 1 \times 10^{-2}$ meter
Kilo	k	10^3	$1\ kg = 1 \times 10^3$ grams
Micro	μ	10^{-6}	$1\ \mu g = 1 \times 10^{-6}$ gram
Milli	m	10^{-3}	$1\ mm = 1 \times 10^{-3}$ meter

[a] Standard for Metric Practice. ANSI/ASTM Designation: E 380-76$^\epsilon$, IEEE Std 268-1976, American Society for Testing and Materials, Philadelphia, Pennsylvania, February 1976. 37 pp.

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This report was assembled for EPA by PEDCo-Environmental, Inc., Cincinnati, OH, and Monsanto Research Corporation, Dayton, OH. Mr. D. L. Becker served as EPA Project Officer, and Dr. C. E. Frank, EPA Consultant, was principal advisor and reviewer.

SECTION 1

INTRODUCTION

Lead is a toxic, heavy metal which is used in lead alkyl production (gasoline additive), lead-acid battery manufacture, and as pigment in paints and ceramics. Lead is present in soil, water, food, air, and in numerous industrial products. Due to its extensive commercial use and presence in the environment, the health hazards of lead exposure to human populations have been recognized.

This report presents an overview of the production, use, environmental significance, and human health effects of lead. An inventory of lead emissions and sources is provided along with technology now in use to control emissions from primary and secondary operations. Related regulatory actions concerning lead are also described.

SECTION 2

SUMMARY

Lead is used in the production of alkyls (gasoline additives), storage batteries, bronze, brass, and other metallic products. A total of 1.2×10^6 metric tons[a] of lead were produced in 1974. Secondary lead production accounted for 48% of this total.

Lead has been recognized as a human health hazard because it is such a widely used toxic substance. The potential for lead poisoning is especially prominent among children, pregnant women, and occupationally exposed workers. The major toxic effects from lead include anemia, neurological dysfunction, and renal impairment.

Potential sources of lead pollution include primary and secondary lead smelting, use of gasoline additives, waste incineration, and coal combustion. Air emissions from operations involving lead totaled 16,414 metric tons in 1970. Lead is also a water contaminant. Effluent from lead storage battery production contains lead sulfate, lead hydroxide, and small amounts of suspended lead. The total amount of lead contained in the water environment is unknown.

Primary lead smelters control lead emissions by means of baghouses which achieve collection efficiencies at 95% to 99%. Secondary lead processing operations use electrostatic precipitators, wet scrubbers, baghouses, and settling chambers to control lead emissions. Effluents containing lead from storage battery production are treated with lime or caustic soda.

Lead has been classified as a priority pollutant for study under the Federal Water Pollution Control Act. Water quality criteria will be developed for priority pollutants by mid-1978.

Table 1 summarizes the extent of lead contamination in the environment, sources and uses of lead, and present control technology.

---

[a] 1 metric ton equals 10^6 grams; conversion factors and metric system prefixes are presented in the prefatory material.

TABLE 1. LEAD

Source	Lead to environment, metric tons/yr: Emissions	Effluents	Controls	Regulatory action
Mining and milling	54	-[a]		EPA has proposed new ambient air quality standard for lead of 1.5 μg lead/m^3 air by 1982.
Metallurgical industries:				
Primary lead	1,540	-	Emissions control by baghouses.	OSHA has proposed setting a standard for lead in the workplace of 50 μg/m^3.
Primary copper	1,540	-		
Primary zinc	220	-		
Primary lead	200	-		
Lead oxide production				
Consumer product manufacturing:				
Storage batteries	435	226	Baghouses, electrostatic precipitators, and wet scrubbers; lime and caustic soda neutralization used to treat effluents from battery manufacture.	Lead is listed as a priority pollutant under Federal Water Pollution Control Act. A threshold limit value (TLV) of 0.15 mg/m^3 for the workspace environment has been adopted.
Gasoline additives	1,700	-		
Pigments	190	-		
Solder	100	-		
Cable covering	45	-		
Type metal	180	-		
Brass and bronze	36	-		
Metallic lead products	80	-		
Other sources:				
Waste incineration:				
Waste oil	2,900	-	Baghouses, electrostatic precipitators, and wet scrubbers; lime and caustic soda neutralization used to treat effluents from battery manufacture.	
Municipal	2,200	-		
Sewage and sludge	180	-		
Coal	590	-		
Oil	80	-		
Iron and steel	1,400	-		
Grey iron foundaries	2,100	-		
Ferroalloy production	64	-		
Cement plants	450	-		
Urban runoff	-	4,500		
TOTALS	16,414	4,726		

[a] Not available.

The sources of lead pollution and the potential health effects of human exposure to lead have been studied extensively. The past unchecked use of lead in many consumer products has led to higher levels of lead in the blood of U.S. children. New standards, such as the EPA-proposed ambient air quality standard for lead are expected to reduce the potential exposure of humans to airborne lead contamination.

Studies have been conducted concerning the environmental levels of lead. For example, the lead concentration in street dust for residential and commercial areas was 1,600 mg/kg and 2,400 mg/kg, respectively. Lead in soil near a lead mine was reported to reach 20,000 mg/kg. This concentration, however, needs further verification due to its excessively high value. On the basis of this report, the following information needs to be obtained:

- Water effluent data for uses of lead or lead products other than lead-acid batteries.
- Populations affected by the various uses of lead.
- Biological and chemical pathways of lead from its sources to the environment.
- The concentration of lead in various plant wastewaters.
- The extent of lead migration from consumer products to humans.
- Confirmation of environmental levels of lead which have been reported.
- The contribution of fugitive emissions to environmental levels of lead.

SECTION 3

SOURCE DESCRIPTION

Major lead production and consumption industries include primary and secondary lead production, lead-acid battery manufacture, lead alkyl production, and brass and bronze production. The following subsections describe the physical and chemical properties of lead, its production, and use.

PHYSICAL AND CHEMICAL PROPERTIES

Lead is a heavy metal (molecular weight, 207.14) which occurs naturally. It is one of the most dense elements known to man. Table 2 lists various physical and chemical properties of lead (1).

PRODUCTION

Almost all of the primary lead production in the United States is from domestic ore. Most is first processed in zinc smelters where residues are sent to lead smelters for recovery. Table 3 lists the capacity and location of six United States lead smelters. Mining of lead deposits in southeastern Missouri, which started in 1967, now accounts for more than 80% of the ore that is mined in the United States specifically for lead. Total production of lead in 1974 from primary smelting amounted to 6.2×10^5 metric tons/yr (2). The secondary lead industry makes about 48% of total domestic production. Storage battery recovery accounts for 57% of this total. All lead-bearing scrap recovery accounted for 86% of the total secondary production of lead metal and alloys. Approximately 130 plants are in operation mainly in major metropolitan areas with a total secondary lead production estimated at 5.9×10^5 metric tons/yr (2).

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(1) Kirk-Othmer Encyclopedia of Chemical Technology, Second Edition, Volume 12. John Wiley & Sons, Inc., New York, New York, 1967. pp. 207-247.

(2) Non-Ferrous Metal Data, 1974. American Bureau of Metal Statistics, Inc., New York, New York, 1975. 143 pp.

TABLE 2. PHYSICAL AND CHEMICAL PROPERTIES OF LEAD (1)

Parameter	Value
Melting point, °C	327.43
Boiling point, °C	1,740
Specific gravity	
At 20°C	11.3437
At 327.43°C	10.686
At 650.0°C	10.302
At 850.0°C	10.078
Vapor pressure, kPa	
At 987°C	0.0
At 1,167°C	1.3
At 1,417°C	13.0
At 1,508°C	26.0
At 1,611°C	53.0
Surface tension, Pa	
At 350°C	44.2
At 400°C	43.8
At 500°C	43.1
Viscosity, 10^{-3}	
At 441°C	2.116
At 551°C	1.700
At 703°C	1.349
At 844°C	1.185
Specific heat, J/kg	
At 0°C	124
At 20°C	128
At 100°C	134
At 327°C	163
At 500°C	154
Latent heat of fusion, 10^3 J/kg	24.5
Latent heat of vaporization, J/kg	849
Thermal conductivity, 10^3 W/m-K	
At 20°C	0.035
At 100°C	11.3
At 327.43°C	39.6
At 600°C	44.9
At 800°C	48.7
Electrolytic soln potential (hydrogen = 0), V	0.122
Brinell hardness (cast)	4.2
Element bond length, Pb-Pb, 10^{-10} m	
At 25°C	3.5003

TABLE 3. PRIMARY LEAD PRODUCERS IN THE UNITED STATES (2)

Company	Location	Capacity, 10^3 metric tons/yr	Date plant built
Amax, Inc.	Boss, MO	127	1968
Asarco, Inc.	East Helena, MT	172	1888
	Omaha, NE	174	1870
	Glover, MO	82	1968
The Bunker Hill Co.	Kellogg, ID	114	1918
St. Joe Minerals	Herculaneum, MO	208	1892

PROCESS DESCRIPTION

Lead is produced by both primary smelting operations, which begin with lead-containing ores, and secondary operations, where lead is recovered from scrap such as lead-acid batteries. In primary lead production, ore is mined and then milled to remove other metals and waste materials such as silicate rock. Milling involves crushing and grinding of the ore followed by floatation. The resulting lead concentrate contains about 45% to 60% lead (1). Figure 1 is a flowsheet of a typical milling process, which also involves zinc milling (1).

After milling, lead concentrate is pressure leached to remove copper, arsenic, and antimony, which would otherwise hinder the smelting operation. It is then sintered (1). Sintered feed is reduced in the blast furnace process to produce a crude lead bullion. Specified amounts of coke, limestone, and other fluxing materials are charged with the sinter through a water-jacketed shaft at the top of the furnace. The material settles to the furnace bottom, which is supported by a thick refractory material.

Air is injected into the charge through side-mounted tuyeres to effect a more complete formation of metallic oxides and thereby raile the temperature of the charge. At the operating temperature of the furnace, coke and resulting carbon monoxide reduce most of the metallic oxides to yield a molten mass of metal. Some of the metallic impurities interact with the fluxing materials to form a slag composed mainly of iron and calcium silicates.

Upon completion of the process, the crude bullion is charged to drossing kettles, and the slag is discharged to a fuming furnace (1). A typical slag analysis is shown in Table 4 (1, 3, 4).

USES

The market for products of the lead industry continues to decrease, principally because of public awareness that lead and its compounds are cumulative poisons. Lead pigments are now rarely used in paints. Although the manufacture of alkyl lead

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(3) Katari, V., G. Isascs, and T. W. Devitt. Trace Pollutant Emissions from the Processing of Metallic Ores. EPA-650/2-74-115, U.S. Environmental Protection Agency, Cincinnati, Ohio, October 1974. 292 pp.

(4) Development Document for Interim Final Effluent Limitations, Guidelines and Proposed New Source Performance Standards for the Lead Segment of the Nonferrous Metals Manufacturing Point Source Category. EPA-440/1-75-032-a, U.S. Environmental Protection Agency, February 1975.

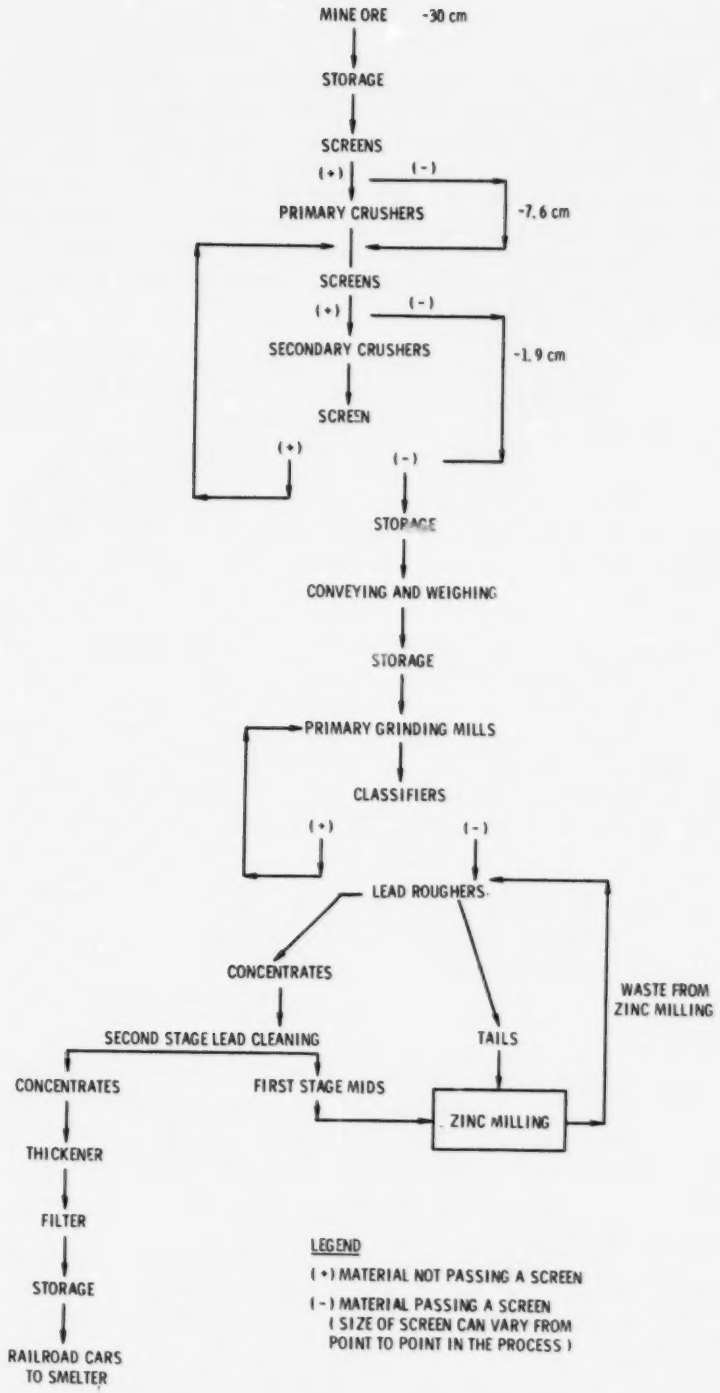

Figure 1. Milling flowsheet (1).

Kirk-Othmer Encylocopedia of Chemical Technology Copyright (C) 1967. Reprinted by permission of John Wiley & Sons, Inc.

for gasoline additives continues as a major market, its use is being restricted. In recent years, other materials have replaced lead in applications such as joining material for cast iron pipe, plumbing, and construction.

TABLE 4. TYPICAL BLAST FURNACE SLAG ANALYSIS (1, 3, 4)

Component	Weight percent
Silver	1.56 to 4.69[a]
Copper	0.10[b]
Lead	1.5 to 3.5
Iron oxide (II)	25.5 to 31.9
Calcium oxide	14.3 to 17.5
Zinc	13.0 to 17.5
Insolubles	22.6 to 26.5[c]
Manganese monoxide	2.0 to 4.5
Arsenic	0.10
Antimony	0.10
Cadmium	0.10
Fluorine	Trace.
Chlorine	Trace.
Germanium	Trace.
Sulfur	0.5 to 1.0

[a] Values for silver in grams per metric ton.

[b] Variable, depending on the furnace charge.

[c] Insolubles include Mg) - Al0 - SiO_2 phases.

Lead metal and alloys were consumed by 600 firms in virtually all states. Transportation was the major end use of lead, 53% as batteries and 16% as gasoline additives. Other major end uses of lead and alloys included electrical materials, ammunition, paints, and construction. The flow of lead in the United States is shown in Figure 2 (5).

There are 202 plants identified as primary producers of lead-acid storage batteries. The states having the highest concentration of plants are California, Florida, Illinois, Pennsylvania, and Texas.

(5) Minerals Yearbook 1973. Volume 1, Metals, Minerals, and Fuels. U.S. Department of the Interior, Washington, D.C., 1975. 1383 pp.

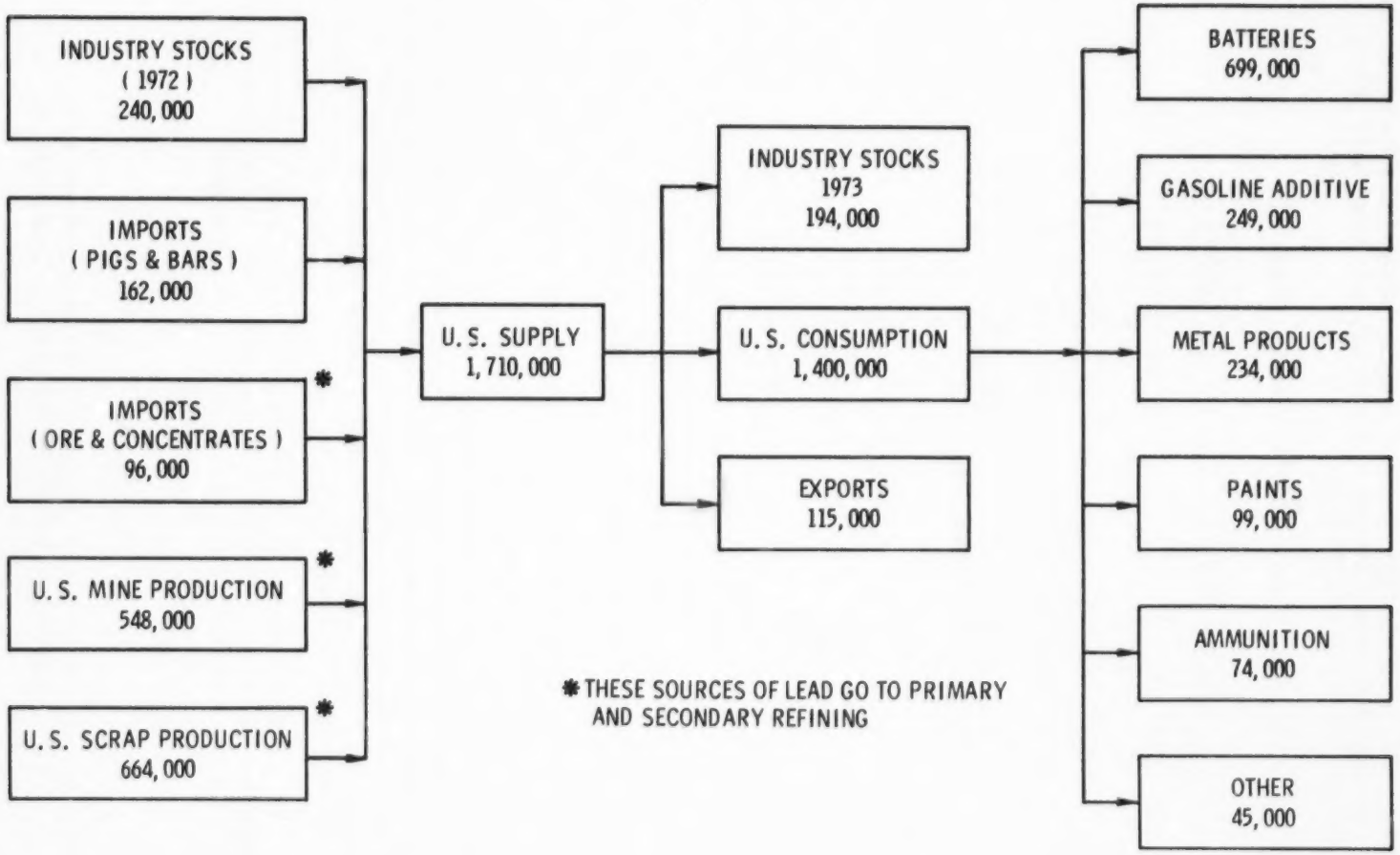

Figure 2. Flow of lead in the United States (1973),[a] metric tons per year (5).

[a]All figures supplied by the U.S. Bureau of Mines 1974 Mineral Industry Surveys.

The lead-acid battery represents the type of storage cell most widely used. The majority of these cells are used for starting, lighting, and igniting functions in automotive and industrial applications. Whereas production plants in the past have been small and located close to their markets, the present trend is toward larger plants. The industry is expected to continue its normal growth rate of 4% to 5% over the next 10 yr. A marketing analyst for one of the big lead-acid battery producers feels that a high demand for this battery will continue through the year 2000. The production of over 50,000 electric or battery-powered cars is expected between 1978 and 1983, and maintenance-free batteries will be original equipment in at least 50% of U.S. passenger cars by about 1980.

Lead alkyls which constitute most of the gasoline antiknock agents used today are manufactured primarily by a sodium-lead alloy process in either batch or continuous reactors. Alkyl lead production is gradually decreasing due to the increasing use of no-lead gasolines in new cars equipped with catalytic mufflers. Extensive process and emission test data are available on the production of lead alkyls.

In the ceramics industry, lead is used mostly in the form of oxides and silicates in the manufacture of certain glasses, glazes, and vitreous enamels. Glass with a high lead content has a higher index of refraction, greater density, lower thermal conductivity, and greater chemical stability than unleaded glass. These characteristics impart greater brilliance, resonance, and toughness to the product. Lead also imparts its radiation absorption quality in proportion to the quantity contained in the glass. Optical glass, the finest glass tableware, most glass for electrical purposes, and windows for radiation shielding contain large amounts of lead.

Lead is an important part of the composition of some fusible alloys, such as those used in sprinkler heads for spraying water at predetermined temperatures and those used in foundries to protect molds. It is also used as a vibration dampener. Lead-asbestos pads are often used under building and machinery foundations.

A growing use of lead compounds is in stabilizers for plastics. Polyvinyl chloride is a material which softens when heated and may be shaped into a variety of useful products. Unfortunately, however, it not only softens but also begins to degrade chemically. The stabilizers slow down this process so that the material is practical for usage.

In pesticides, lead arsenate is the only lead compound of commercial importance. Litharge is reacted with arsenic acid in the presence of an acetic acid catalyst to produce lead

arsenate. The batch is heated to about 70°C and agitated for approximately 2 hr. The resulting lead arsenate precipitate is subsequently pumped to a dryer from which the dry powder is conveyed to storage or shipping. Lead arsenate is sometimes used in dry powder form and sometimes applied in solution.

In addition to lead metal and lead alkyl compounds used as gasoline additives, there are 74 other lead compounds of significance produced in the United States. Table 5 is a listing of these products with their end uses, producing companies, and production sites.

TABLE 5. FACILITIES PRODUCING LEAD CHEMICALS

Chemical	Company	Location	Uses
Lead acetate	Mallinckrodt, Inc./Industrial Chemicals Division	St. Louis, MO	Medicine; lead salts; textiles dyeing; waterproofing; varnishes; lead driers; chrome pigments; gold cyanidation process; insecticide; antifouling paints; analytical reagent.
	Richardson-Merrell, Inc./J. T. Baker Chemical	Phillipsburg, NJ	
Lead acetyacetonate	MacKenzie Chemical Works, Inc.	Central Islip, NY	
Lead alkyls	E. I. DuPont de Nemours & Co., Inc.	Antioch, CA	Includes tetraethyl lead and tetramethyl lead. Used as antiknock in aviation and other motor gasolines.
		Deepwater, NJ	
	Ethyl Corp.	Baton Rouge, LA	
		Pasadena, TX	
	Nalco Chemical Co.	Freeport, TX	
	PPG Industries, Inc./Chemical Division	Beaumont, TX	
Lead arsenate	Dimensional Pigments, Inc.	Bayonne, NJ	Insecticide; herbicide.
	Los Angeles Chemical Co.	South Gate, CA	
	Rona Pearl, Inc.	Bayonne, NJ	
	Woolfork Chemical Works, Inc.	Fort Valley, GA	
Lead benzoate	City Chemical Corp.	Jersey City, NJ	
Lead bisilicate	N L Industries, Inc./Industrial Chemicals Division	Charleston, WV	
Lead bromide	City Chemical Corp.	Jersey City, NJ	
Lead carbonate	Dimensional Pigments, Inc.	Bayonne, NJ	Industrial paint pigment.
	N L Industries, Inc./Industrial Chemicals Division	Oakland, CA	
	Metal Division	Chicago, IL	
	Richardson-Merrell, Inc./J. T. Baker Chemical	Phillipsburg, NJ	
	Rona Pearl, Inc.	Bayonne, NJ	
	Smith Chemical & Color Co., Inc.	Jamaica, NY	
Lead chloride	Richardson-Merrell, Inc./J. T. Baker Chemical Co., Inc.	Phillipsburg, NJ	Preparation of lead salts; lead chromate pigment; analysis.

(continued)

TABLE 5 (continued)

Chemical	Company	Location	Uses
Lead chlorosilicate	N L Industries, Inc./Industrial Chemicals Division	Philadelphia, PA	Vinyl electrical insulation and tapes.
Lead chromate	Hercules, Inc./Coatings & Specialty Products Dept.	Glens Falls, NY	Pigment in industrial paints, rubber plastics; ceramic coatings.
	Hydrite Chemical Co.	Milwaukee, WI	
	Mineral Pigments Corp./Chemical Color Division	Beltsville, MD	
	Nichem, Int.	Chicago, IL	
	Richardson-Merrell, Inc./J. T. Baker Chemical Co., subsidiary	Phillipsburg, NJ	
Lead citrate	City Chemical Corp.	Jersey City, NJ	
Lead compounds, organic (unspecified)	PPG Industries, Inc./Chemical Division	Beaumont, TX	
Lead cyanide	City Chemical Corp.	Jersey City, NJ	Metallurgy.
Lead dioxide	Eagle-Picher Industries, Inc./Chemicals and Fibers	Joplin, MO	Oxidizing agent; electrodes; lead-acid storage batteries; curing agent for polysulfide elastomers; textiles (mordant, discharge in dyeing with indigo); matches; explosives; analytical reagent.
	Hummel Chemical Co., Inc.	S. Plainfield, NJ	
Lead 2-ethylhexanoate	Ferro Corp./Chemical Division	Bedford, OH	Lubricating greases; gel thickeners; in paints as dryers and flatting agents.
	Interstab Chemicals, Inc.	New Brunswick, NJ	
	Mooney Chemicals, Inc.	Franklin, PA	
	N L Industries, Inc./Industrial Chemicals	Philadelphia, PA	
	The Shepherd Chemical Co.	Cincinnati, OH	
	Tenneco, Inc./Tenneco Chemicals	Elizabeth, NJ	
	Troy Chemical Corp.	Long Beach, CA	
	Witco Chemical Corp./Organics Division	Newark, NJ	
		Clearing, IL	
		Lynwood, CA	

(continued)

TABLE 5 (continued)

Chemical	Company	Location	Uses
Lead fluoborate	C. P. Chemicals, Inc.	Sewaren, NJ	
	Harstan Chemical Corp.	Brooklyn, NY	
	Kewanee Industries, Inc./Harshaw Chemical	Cleveland, OH	
Lead fluoride	Pennwalt Corp./Ozark-Mahoning	Tulsa, OK	Electronic and optical applications; starting material for growing single crystal solid-state lasers; high temperature dry film lubricants in the form of ceramic-bonded coatings.
Lead formate	N L Industries, Inc./Industrial Chemicals	Philadelphia, PA	Reagent in analytical determination.
Lead fumarate, tetrabasic	N L Industries, Inc./Industrial Chemicals	Philadelphia, PA	Heat stabilizer for electrical grade plastisols, phonograph records; and electrical insulation.
Lead hydroxide	City Chemical Corp.	Jersey City, NJ	Lead salts; lead dioxide.
Lead hydroxy neodecanoate	Mooney Chemicals, Inc.	Franklin, PA	
Lead iodate	Deepwater Chemical Co., LTD.	Irvine, CA	
	R.S.A. Corp.	Ardsley, NY	
Lead iodide	City Chemical Corp.	Jersey City, NJ	Bronzing; mosaic gold; printing; photography; cloud seeding.
	Deepwater Chemical Co., Ltd.	Irvine, CA	
	R.S.A. Corp.	Ardsley, NY	
Lead isocarboxylate	Mooney Chemicals, Inc.	Franklin, PA	
Lead lactate	City Chemical Corp.	Jersey City, NJ	
Lead linoleate	The Shepherd Chemical Co.	Cincinnati, OH	Medicine; dryer in paints and varnishes
	Troy Chemical Corp.	Newark, NJ	
Lead maleate, tribasic	N L Industries, Inc./Industrial Chemicals	Philadelphia, PA	Vulcanizing agent for chlorosulfonated polyethylene. Highly basic stabilizer with high heat stability in vinyls.

(continued)

TABLE 5 (continued)

Chemical	Company	Location	Uses
Lead manganese naphthenate	Interstab Chemicals, Inc.	New Brunswick, NJ	
Lead manganese tallate	Mooney Chemicals, Inc.	Franklin, PA	
Lead metaborate	Richardson-Merrell, Inc./J. T. Baker Chemicals	Phillipsburg, NJ	Varnish and paint dryer; waterproofing paints; lead glass; galvanoplastic products.
Lead metavanadate	City Chemical Corp.	Jersey City, NJ	Preparation of other vanadium compounds; pigment.
Lead molybdate	City Chemical Corp.	Jersey City, NJ	Analytical chemistry; pigments (see molybdate oranges); single crystals available for electronic and optical uses.
Lead naphthenate	Ferro Corp./Ferro Chemical Division Interstab Chemicals, Inc. Mooney Chemicals, Inc. The Norac Co., Inc./Mathe Division The Shepherd Chemical Co. The Sherwin-Williams Co./Coatings Tenneco, Inc./Tenneco Chemicals, Inc. Troy Chemical Corp. Witco Chemical Corp./Organics Division	Bedford, OH New Brunswick, NJ Franklin, PA Lodi, NJ Cincinnati, OH Cleveland, OH Garland, TX Emeryville, CA Elizabeth, NJ Long Beach, CA Newark, NJ Clearing, IL Lynwood, CA	Paint and varnish dryer; wood preservative; insecticide; catalyst for reaction between unsaturated fatty acids and sulfates in the presence of air; lube oil additive.
Lead neodecanoate	Mooney Chemicals, Inc. The Shepherd Chemical Co.	Franklin, PA Cincinnati, OH	
Lead nitrate	Mallinckrodt, Inc./Industrial Chemicals Richardson-Merrell, Inc./J. T. Baker Chemical G. Frederick Smith Chemical Co.	St. Louis, MO Phillipsburg, NJ Columbus, OH	Lead salts; mordant in dyeing and printing calico; matches; paint pigment; mordant for staining mother-of-pearl; oxidizer in the dye industry; sensitizer in photography; explosives; tanning process engraving and lithography.

(continued)

TABLE 5 (continued)

Chemical	Company	Location	Uses
Lead nitroresorcinal, mono	Typer Corp./Atlas Powder Co.	Tamaqua	
Lead oleate	The Norac Co., Inc./Mathe Division	Lodi, NJ	Varnishes; laquers; paint dryers; high-pressure lubricants.
	The Shepherd Chemical Co.	Cincinnati, OH	
	Tenneco, Inc./Tenneco Chemicals, Inc.	Elizabeth, NJ Long Beach, CA	
Lead oleate-linoleate	Troy Chemical Corp.	Newark, NJ	
Lead oxalate	City Chemical Corp.	Jersey City, NJ	
Lead oxide, red	Eagle-Pitcher Industries, Inc./Chemicals and Fibers	Joplin, MO	Storage batteries; glass; metal-protective paints; pottery and enameling; varnish; purification of alcohol; packing pipe joints.
	N L Industries, Inc./Industrial Chemicals	Charleston, WV Oakland, CA Philadelphia, PA St. Louis, MO	
	Metal Division	Atlanta, GA Chicago, IL Dallas, TX Los Angeles, CA	
	RSR Corp./RSR/Quemetco, Inc.	City of Industry, CA Indianapolis, IN Middletown, NY Seattle, WA	
Lead oxide, yellow	ASARCO, Inc.	Denver, CO	Storage batteries; ceramic cements and fluxes, pottery and glazes; glass; chromium pigments; oil refining; varnishes, paints, enamels, ink, linoleum; insecticides; cement (with glycerin); acid-resisting compositions; match-head compositions; other lead compositions; rubber
	Eagle-Pitcher Industries, Inc./Chemicals and Fibers	Joplin, MO	
	N L Industries, Inc./Industrial Chemicals	Charleston, WV Oakland, CA Philadelphia, PA St. Louis, MO	
	Metal Division	Atlanta, GA Chicago, IL Dallas, TX Los Angeles, CA Portland, OR	

(continued)

TABLE 5 (continued)

Chemical	Company	Location	Uses
Lead oxide, yellow (continued)	RSR Corp./RSR/Quemetco, Inc.	City of Industry CA Indianapolis, IN Middletown, KY Seattle, WA	accelerator (dry heat only).
Lead perchlorate	G. Frederick Smith Chemical Co.	Columbus, OH	
Lead phosphate	Rona Pearl, Inc.	Bayonne, NJ	
Lead phosphite	N L Industries, Inc./Industrial Chemicals	Philadelphia, PA	Heat and light stabilizer for vinyl plastics and chlorinated paraffins. As an ultraviolet screening and antioxidizing stabilizer for vinyl and other chlorinated resins in paint and plastics.
Lead phthalate, dibasic	N L Industries, Inc./Industrial Chemicals Division	Philadelphia, PA	Heat and light stabilizer for general vinyl use.
Lead pyrophosphate	City Chemical Corp.	Jersey City, NJ	
Lead β-resorcylate	The Shepherd Chemical Co.	Cincinnati, OH	
Lead salicylate	N L Industries, Inc./Industrial Chemicals	Oakland, CA Philadelphia, PA	Stabilizer or costabilizer for flooring and other vinyl compounds requiring good light stability.
Lead sesquichloride	City Chemical Corp.	Jersey City, NJ	
Lead silicate	N L Industries, Inc./Industrial Chemicals	Charleston, WV	Ceramics; fireproofing fabrics.
Lead silicates, unspecified	Eagle-Picher Industries, Inc./Chemicals and Fibers	Joplin, MO	Ceramics; fireproofing fabrics.

(continued)

TABLE 5 (continued)

Chemical	Company	Location	Uses
Lead silicate sulfate, basic	N L Industries, Inc./Industrial Chemicals	Philadelphia, PA St. Louis, MO	Pigment in industrial paints.
Lead silico chromate, basic	N L Industries, Inc./Industrial Chemicals	St. Louis, MO	Corrosion inhibitive pigment for metal protectice coatings, primers, and finishes; high gloss industrial enamels.
Lead stannate	City Chemical Corp	Jersey City, NJ	Additive in ceramic capacities.
Lead stearate	Diamond Shamrock Corp./Process Chemicals Division N L Industries, Inc./Industrial Chemicals The Norac Co., Inc./Mathe Division Smith Chemical and Color Co., Inc. Witco Chemical Corp./Organics Division	Cedartown, GA Philadelphia PA Lodi, NJ Jamaica, NY Clearing, IL	Varnish and lacquer dryer; high-pressure lubricants; lubricant in extrusion processes; stabilizer for vinyl polymers; corrosion inhibitor for petroleum; component of greases, waxes and paints.
Lead stearate, dibasic	Diamond Shamrock Corp./Process Chemicals Division N L Industries, Inc./Industrial Chemicals The Norac Co., Inc./Mathe Division	Cedartown, GA Philadelphia, PA Lodi, NJ	
Lead styphnate	Olin Corp./Industrial Products Winchester Group	Niagara Falls, NY East Laton, IL	Explosive
Lead subacetate	Allied Chemical Corp./Specialty Chemicals Richardson-Merrell, Inc./J. T. Baker Chemicals	Marcus Hook, PA Phillipsburg, NJ	
Lead succinate	City Chemical Corp.	Jersey City, NJ	
Lead sulfate	City Chemical Corp. Richardson-Merrell, Inc./J. T. Baker Chemicals	Jersey City, NJ Phillipsburg, NJ	Storage batteries; paint pigments.
Lead sulfate, tribasic	N L Industries, Inc./Industrial Chemicals	Oakland, CA Philadelphia, PA St. Louis, MO	Electrical and other vinyl compounds requiring high heat stability.

(continued)

TABLE 5 (continued)

Chemical	Company	Location	Uses
Lead tallate	Ferro Corp./Ferro Chemical Division	Bedford, OH	Lubricating greases; gel thickeners; in paints as dryers and flatting agents.
	Interstab Chemicals, Inc.	New Brunswick, NJ	
	Mooney Chemicals, Inc.	Franklin, PA	
	The Shepherd Chemical Co.	Cincinnati, OH	
	Tenneco, Inc./Tenneco Chemicals, Inc.	Elizabeth, NJ	
	Troy Chemical Corp.	Long Beach, CA	
		Newark, NJ	
Lead tartrate	City Chemical Corp.	Jersey City, NJ	
Lead telluride	Thiokol Corp./Ventron Corp./Alfa Products	Danvers, MA	Photoconductors and semiconductors in thermocouples.
Lead tetraacetate	Syntex Corp./Arapahoe Chemicals	Boulder, CO	Selectric oxidizing agent in organic synthesis; laboratory reagent.
Lead tetrafluoride	Pennwalt Corp./Ozark-Mahoning	Tulsa, OK	
Lead thiocyanate	City Chemical Corp.	Jersey City, NJ	Ingredient of primary mixture for small-arms cartridges; safety matches; dyeing.
	Hummel Chemical Co., Inc.	S. Plainfield, NJ	
Lead thiosulfate	City Chemical Corp.	Jersey City, NJ	
Lead titanate	N L Industries, Inc./Industrial Chemicals	Niagara Falls, NY	Industrial paint pigment.
Lead tungstate	City Chemical Corp.	Jersey City, NJ	Pigment.
Lead zirconate	N L Industries, Inc./Industrial Chemicals	Niagara Falls, NY	
Lead zirconate titanate	N L Industries., Inc./Industrial Chemicals	Niagara Falls, NY	Used as an element in hi-fi sets and as a transducer for ultrasonic cleaners; ferro-electric material in computer memory units.
	Transelco, Inc.	Penn Yan, NY	
Tetraphenyllead	Thiokol Corp./Ventron/Alfa Products	Danvers, MA	

SECTION 4

ENVIRONMENTAL SIGNIFICANCE AND HEALTH EFFECTS

ENVIRONMENTAL SIGNIFICANCE

Background Levels

Lead is naturally present in food and water, but it may be classified as an unnatural component of the air at the concentration levels common to urban atmospheres. The relative contributions of these sources to the lead absorption of adults and children must be addressed separately. The lead absorbed by children per unit body weight is about two and one-half times that of adults; furthermore, they exhibit a lower toxic threshold. Child intake of lead, which has resulted from the ingestion of peeling lead paint and other lead-containing products, has resulted in many cases of lead poisoning.

The lead concentration in water supplies generally does not exceed 50 mg/m^3. However, when lead pipes or tanks are used and when the water is soft, lead concentrations may be as high as 2 g/m^3. In a national study, the lead level in rain water was found to have a mean of 34 mg/m^3. In areas of heavy traffic, lead in rain may exceed 100 mg/m^3. Much of the lead entering the aquatic systems via precipitation and runoff is not water-soluble and apparently is removed by sedimentation. The low solubility of lead in water also is an important factor in terrestrial systems because it affects the ability of plants to assimulate lead.

The natural concentration of lead in soil is in the range of 2 mg/kg to 200 mg/kg with mean values of about 16 mg/kg, but the variation from one location to another is considerable. The concentration of lead in street dust and surface soil may be extremely high and thus represent a hazard to children. For example, the mean lead concentration in street dust from residential and commercial areas in 77 midwestern cities in the United States amounted to about 1,600 mg/kg and 2,400 mg/kg, respectively. It is also reported that lead in soil near a lead mining area in Idaho reached 20,000 mg/kg.

Grass samples may show high lead concentrations near roads with heavy traffic, mean values ranging from about 250 mg/kg at the roadside to about 100 mg/kg at a distance of 25 m. This is

mostly due to external contamination because the uptake of lead by plants from soil does not seem to be much influenced by the concentration of lead in soil.

Lead levels in different foods can vary widely. Levels reported are:

	mg/kg
Condiments	1
Fish and seafood	0.2 to 2.5
Meat and eggs	0.2 to 0.4
Grains and vegetables	1.4

The amount of lead in milk is of particular concern, since milk is the main dietary constituent for infants. Human breast milk contains lead in concentrations of about 5 mg/m^3 to 12 mg/m^3. Unprocessed cow's milk has a similar concentration. Processing may considerably influence lead content. Whole bulk milk was found to have about 40 mg/m^3 in contrast to 200 mg/m^3 in milk that had been processed by evaporation.

Lead Emissions

Lead levels in ambient air have been found to average 1 $\mu g/m^3$ to 3 $\mu g/m^3$ in urban areas, 0.1 $\mu g/m^3$ to 0.5 $\mu g/m^3$ in suburban areas, and less than 0.05 $\mu g/m^3$ in rural areas except for locations in the vicinity of heavy traffic. The concentration of lead in ambient air can be closely correlated with the density of vehicular traffic. Based upon Figure 2, the combustion of leaded gasoline is the largest air emission source of lead nationally (249,000 metric tons/yr). Primary and secondary lead smelting, brass manufacturing, and lead alkyl manufacturing may also result in high ambient concentrations. Coal, typically containing 7 parts per million (ppm) of lead, is another potential source. Lead emissions also result from lead smelters and foundries, manufacture of lead products, and the processing of materials containing lead. Table 6 shows the amount of lead emitted by various sources (6).

An important characteristic in assessing the significance of lead air emissions is particle size distribution. Residence time in the atmosphere and degree of dispersion from the point of emission are determined primarily by particle size. Also, small particles tend to be retained by the lungs and accessory airways when inhaled, to be absorbed or coughed up and swallowed later.

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(6) Davis, W. E. Emission Study at Industrial Sources of Lead Air Pollutants 1970. Publication No. APTD-1543, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, April 1973. 183 pp.

TABLE 6. LEAD EMISSIONS BY INDUSTRIAL SOURCE (1970) (6)

Source	Emissions, metric tons/yr	Emissions, %
Mining and milling	54	0.3
Metallurgical industries:		21.4
Primary lead	1,540	
Primary copper	1,540	
Primary zinc	220	
Secondary lead	200	
Lead oxide production	130	0.8
Consumer product manufacturing:		17.0
Storage batteries	435	
Gasoline additives	1,700	
Pigments	190	
Solder	100	
Cable covering	45	
Type metal	180	
Brass and bronze	36	
Metallic lead products	80	
Other emission sources:		60.5
Waste incineration:		
Waste oil	2,900	
Municipal incineration	2,200	
Sewage and sludge incineration	180	
Coal	590	
Oil	80	
Iron and steel	1,400	
Grey iron foundries	2,100	
Ferroalloy production	64	
Cement plants	450	
TOTAL	16,414	100

Water Contamination

Lead enters water systems through precipitation, lead dust fallout, soil erosion, soil leaching, municipal and industrial waste discharges, and runoff from streets and other surfaces. An EPA study indicated that approximately 4,500 metric tons/yr of lead entered the aquatic environment as a result of urban runoff (7).

(7) Water Quality Criteria. EPA-440/9-76-023, U.S. Environmental Protection Agency, Washington, D.C., September 1976. 501 pp.

Wastewater effluent from industrial processes where lead is used can present a potential hazard of water contaminations. For example, the sludge from the treatment systems of a typical lead-acid battery manufacture process contains lead sulfate, lead hydroxide, and a small amount of suspended lead. These materials constitute a potentially severe environmental hazard due to their relative solubilities and toxicity. The effluent factor from a lead-acid plant producing 8,230 metric tons/yr of batteries is 0.3 g lead/kg of battery manufactured. Since 6.86×10^5 metric tons of batteries are produced annually (8), and assuming batteries weigh 14 kg, it is estimated that 226 metric tons/yr of lead enter aquatic systems from battery manufacture.

HEALTH EFFECTS

The hazard of lead has long been recognized due to its high toxicity and widespread use. Several lead salts have been found to be carcinogenic in animal studies. Of special concern is the potential for lead poisoning in sensitive populations, particularly in children, pregnant women, and certain occupationally exposed groups. Lead, a systemic poison, exhibits a wide range of clinical effects dependent upon population groups exposed and level of exposure. The greater sensitivity of children results in relatively more frequent childhood poisoning especially from ingestion of lead pigment paints. Maternal overexposure results in greater toxic effects on the fetus than the mother. Livestock and water fowl lead poisoning is also reported as a chronic problem.

The major toxic effects of lead include anemia, neurological dysfunction, and renal impairment (7). Common symptoms of lead poisoning are anemia, severe intestinal cramps, nerve paralysis, loss of appetite, and fatigue (7).

A recent study revealed that 90% of the children examined because of excessive lead absorption had pica. In children with blood lead concentrations equal to or greater than 0.6 g/m^3, 75% lived in homes with at least one lead painted surface, but high lead levels found in children are not always caused from painted surfaces. High concentrations of lead in soil in the vicinity of some houses may be another source of lead intake related either to the weathering of lead-based paint or to the accumulation of lead from automobile exhausts. Children may also be exposed to lead from colored newsprint or lead-painted toys.

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(8) Boyle, T. F., and R. B. Reznik. Source Assessment: Lead-Acid Batteries. Contract 68-02-1874, U.S. Environmental Protection Agency, Cincinnati, Ohio. (Draft report submitted to the EPA by Monsanto Research Corporation, June 1976.) 71 pp.

Lead in illicitly distilled whiskey may contain greater than 1 g/m^3 concentrations of lead. This causes chronic poisoning.

Lead content in tobacco may vary from about 3 µg to 12 µg per cigarette, of which about 2% is transferred to the mainstream smoke, resulting in an inhalation of about 1.2 µg to 4.8 µg lead per 20 cigarettes.

SECTION 5

CONTROL TECHNOLOGY

PRIMARY LEAD PRODUCTION

Primary lead smelters control particulate emissions from their operations by using baghouses which achieve collection efficiencies of 95% to 99%+. Particulate collection at higher temperatures such as in a hot electrostatic precipitator (ESP) prevents efficient collection of lead since it can remain in a gaseous state. Control technology presently in use at primary smelters is described in Table 7 (9).

TABLE 7. ATMOSPHERIC CONTROL SYSTEMS ON PRIMARY BLAST FURNACES (9)

Plant	Control system
Bunker Hill/Kellogg, ID	Blast furnace gas stream joined to weak sinter gas stream and hygiene air, passes through baghouse and stack.
Amax, Inc./Boss, MO	Blast furnace gases join sinter weak gases, then to baghouse and stack.
St. Joe/Herculaneum, MO	Blast furnace gases join sinter weak gases and other gases pass through baghouses and stack.
ASARCO/East Helena, MT	Blast furnace gases join reverb and ventilation gases, then pass through three baghouses in parallel with stack for each house.
ASARCO/Glover, MO	Blast furnace gases to water spray, baghouse, and three stacks.
ASARCO/El Paso, TX	Blast furnace and dross furnace gases mix, then pass through a spray chamber and a baghouse, then out six stacks.

(9) Systems Study for Control of Emissions Primary Nonferrous Smelting Industry. Arthur G. McKee & Co. for U.S. Department of Health, Education, and Welfare, Washington, D.C., June 1969.

SECONDARY LEAD PRODUCTION AND USE

A summary of multimedia emission control information for the secondary lead industry is shown in Table 8. Particulate control efficiencies associated with smelting furnaces are reported to be 98.4% to 99.8%. Solid wastes that have high lead contents such as collected particulates, furnace residues from reverberatory smelting, and solids from zinc leaching are recycled to recover the lead value. The solid wastes from the battery crushing process and from furnace slags are usually disposed in open dumps.

The character of hazardous wastewater treatment sludges from a lead-acid battery plant is determined largely by the type of water treatment employed. Based upon a total of 202 lead-acid battery plants in the United States, three-fourths of these plants (75%) are currently neutralizing their wastewater effluents using either caustic soda or lime and discharging directly to waterways or to municipal treatment plants. Of the 150 plants using neutralization, an estimated 60 plants treat the wastewater to precipitate lead-containing sludges which are destined for land disposal. Fourteen of these later plants are using lime treatment to produce a calcium sulfate-lead sludge, while the remaining plants, 46, are using caustic to produce a lead hydroxide-sulfate sludge. The numbers of plants using either lime treatment or caustic treatment is expected to increase dramatically in 1977 and 1983 when the EPA effluent guidelines take effect.

Production of lead alkyls results in lead particulate emissions in the size range of 0.01 μm to 2 μm. High-energy venturi scrubbers and cyclones with water sprays are the type of equipment most often used to control particulate emissions. Based on data from six manufacturing plants, lead emissions ranged from 0.4 to 15 kg/metric ton of lead used, averaging 6.8 kg/metric ton.

TABLE 8. CONTROL SUMMARY FOR SECONDARY LEAD

Process and pollution control	Air emissions	Aqueous effluents	Solid wastes
Battery breaking	Dirt, battery case materials, and lead compounds.	Sulfuric acid, water, and dissolved compounds of lead	Organic materials and compounds.
Control	None reported.	None reported.	Landfill.
Crushing	Dust.	None reported.	None reported.
Control	None reported		
Rotary/tube sweating	Gases: Sulfur oxides, nitrogen oxides, hydrocarbons, and fuel combustion products. Particulates: Metal fumes, dusts, soot, and fly ash.	None reported	Metal and organic residues.
Control	Baghouses.		Sent to refining processes.
Reverberatory sweating	Gases: Sulfur oxides, nitrogen oxides, hydrocarbons, and fuel combustion products. Particulates: Metal fumes, dusts, soot, and fly ash.	None reported.	Metal and organic residues and collected particulates.
Control	Baghouses.		Sent to refining processes.
Zinc leaching	None reported.	Spent leaching liquor containing sulfuric acid, zinc, antimony, lead, copper, sulfides, and chlorides.	Undissolved residue.
Control		Chemical neutralization and settling ponds.	Fed to blast (cupola)
Shaft furnace smelting	Gases: Sulfur oxides and combustion products. Particulates: Flue dusts and lead.	Lime scrubbing and metal cooling effluent.	Scrubber effluent and particulate collection.
Control	Baghouses and wet scrubbers.	Settling ponds for scrubber effluent.	Landfill.

(continued)

TABLE 8 (continued)

Process and pollution control	Air emissions	Aqueous effluents	Solid wastes
Rotary furnace melting	Gases: Sulfur oxides and combustion products.	Lime scrubbing and metal cooling effluent.	Wet scrubber effluent and particulate collection.
Control	Baghouses and wet scrubbers.	Settling ponds for scrubber effluent.	Landfill.
Reverberatory smelting	Gases: Sulfur oxides and combustion gases. Particulates: Flue dusts such as lead.	Lime scrubbing and metal cooling effluent.	Wet scrubber effluent and particulate collection.
Control	Baghouses and wet scrubbers.	Settling ponds for scrubber effluent.	Landfill or road surfacing.
Blast furnace smelting	Gases: Sulfur oxides and combustion products. Particulates: Flue dusts and lead.	Lime scrubbing and metal cooling effleunt.	Furnace slag, effluent from scrubber, and particulate collection.
Control	Baghouses and wet scrubbers.	Settling ponds for scrubber effluent.	Landfill.
Reverberatory smelting	Gases: Sulfur oxides and fuel combustion products. Particulates: Oxides, sulfides, sulfates, and chlorides of lead, tin, copper, antimony, arsenic, and zinc.	Wet scrubber effluent.	Collected particulate and furnace slag.
Control	Settling chambers, baghouses, and wet scrubbers.	Settling ponds.	Collected particulate fed to leaching process or recirculated to the furnace and slag fed to blast (cupola) furnace.

(continued)

TABLE 8 (continued)

Process and pollution control	Air emissions	Aqueous effluents	Solid wastes
Blast (cupola) furnace smelting	Gases: Carbon monoxide, hydrocarbons, sulfur oxides, and nitrogen oxides. Particulates: Metal fumes, coke dusts, oil, and smoke.	Wet scrubber effluent.	Particulate collection and furnace slag.
Control	Afterburners, wet scrubbers, and baghouses.	Settling ponds.	Collected particulates fed to leaching process and slag is sent to landfills.
Casting	Gases: Incinerable fumes. Particulates: Dust and metal oxides.	None reported.	Particulate collection.
Control	Baghouses, afterburners and electrostatic precipitators.		Landfill.
Kettle (softening) refining	Gases: Fuel combustion products. Particulates: Lead and lead compounds.	None reported.	Particulate collection skimmings.
Control	Baghouses.		Recycled to refining processes.
Kettle (alloying) refining	Gases: Fuel combustion products. Particulates: Lead and lead compounds.	None reported.	Particulate collection.
Control	Baghouses.		Recycled to refining processes.

(continued)

TABLE 8 (continued)

Process and pollution control	Air emissions	Aqueous effluents	Solid wastes
Kettle oxidation	Gases: Fuel combustion products. Particulates: Lead oxides, lead metal, and metals.	None reported.	Collected particulates.
Control	Baghouses.		Recycled to refinery process.
Reverberatory oxidation	Gases: Fuel combustion products. Particulates: Lead oxides.	None reported.	Collected particulates.
Control	Baghouses.		Recycled to refinery process.

SECTION 6

REGULATORY ACTION IN PROGRESS

Under the Federal Water Pollution Control Act, as amended, lead has been classified as a priority pollutant for study. Best available technology and new source and pretreatment standards are to be reviewed and revised by the end of 1979. Water quality criteria will also be developed for priority pollutants by mid-1978.

A TLV of 0.15 mg/m^3 has been adopted for lead in the workspace environment (10). A new ambient air quality standard for lead has been proposed by EPA. The standard would set a monthly average of 1.5 μg lead/m^3 air by 1982. Since it is expected that most cars will be equipped with catalytic converters by 1985, virtually no leaded gasoline will be available for sale, thus, eliminating a major source of lead pollution.

OSHA has proposed setting a standard of 50 $\mu g/m^3$ for lead emissions in the workplace.

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(10) TLVs® Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1976. American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio, 1975. 94 pp.

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